Quality Control and Material Handling System Using Cognex Vision

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Abstract:

Programmable logic controllers have been an integral part of factory automation and industrial process control for decades. These systems perform many functions, providing a variety of analog and digital input and output interfaces, signal processing, data conversion and various communication protocols. The sole purpose is to develop a material inspection and sorting system prototype and also demonstrate the Cognex camera methodology on the Human Machine Interface (HMI). This system can handle a series of metallic and non-metallic objects with the barcode encoded. Mitsubishi controller FX3U-16MR/ES manufactured is the brain of this system. To control the speed of the conveyor variable frequency drive (VFD) is programmed and used. E-Designer-7 software is used to design the screen. We scanned the barcode on the metallic tin via Cognex vision system. The material of the metallic tin is scanned by the inductive sensor and if the barcode is good and the material of the metallic tin is metal, the metallic tin is considered as good metallic tin and will pass on conveyor till the good part section and if the metallic tin is nonmetal or the barcode is bad, it continues on conveyor till bad part section. The whole operation can be controlled using the HMI. This application can be implemented in various manufacturing industries such as but not limited to packaging industries, automobile industry. The Cognex camera have variety of application in pharmaceutical, electronic industries, who wants to keep a track data and product on the conveyor. The HMI has been designed to read all important data and control and monitor the system.

Introduction:

This project is a prototype of a Material Inspection and Sorting system, demonstrating all the instruction on a Mitsubishi PLC (programmable logic control). Programmable logic controllers (PLCs) have been an integral part of factory automation and industrial process control for decades. PLCs control a wide array of applications from simple lighting functions to environmental systems to chemical processing plants. These systems perform many functions, providing a variety of analog and digital input and output interfaces; signal processing; data conversion; and various communication protocols. All of the PLC's components and functions are centered on the controller, which is programmed for a specific task. In this project the assembly consists of a Mitsubishi's VFD (Variable Frequency Drive), HMI Screen (E1061), Conveyor Belt , 3phase motor and its gear box, Two air cylinders and some proximity & optical sensors, Inductive sensors, relays, switches and 24 VDC power supply unit. All these components are integrated together using PLC as shown in figure 1.1. The VFD is used to control the speed of the conveyor belt, the total system is controlled by the user through the HMI. PLC Mitsubishi, Model: FX3U-16MR/ES is used in this project FX 3U- is the series name, 16 indicate no. of inputs/ outputs. R/ES : AC power supply/24V DC (sink/source) input/relay output, this can be operated in both sink/source mode. Input side is connected to Inductive Proximity sensor which generates electromagnetic field over the sensing surface. The presence of a metallic objects (actuator) in the operating area causes a dampening of the oscillation amplitude. The changes in such oscillation is identified by a threshold circuit that changes the output of the sensor which is connected as input to PLC.

VFD (Variable Frequency Drive) parameters are set and installed to output side of PLC. Motor is connected to VFD using delta type connection. VFD takes signals form PLC and based on the set parameter list it makes the conveyor belt run in preset speed. VFD gives a flexibility to move the conveyor belt in forward/ reverse direction but in our application we are using only one direction at variable speed. Festo's self-adjusting cushioning PPS air cylinders are used to push objects out of the conveyor belt. This air cylinder is installed with a proximity sensor and once the piston moves to and from, it gives an output signal which in turn is connected as input to PLC.

Circuit diagram of this project is laid using AutoCAD 2015 which is shown in figure 6. Power supply for PLC and VFD is 110V-AC. Sensors, HMI screen are operated at 24 VDC power supply.

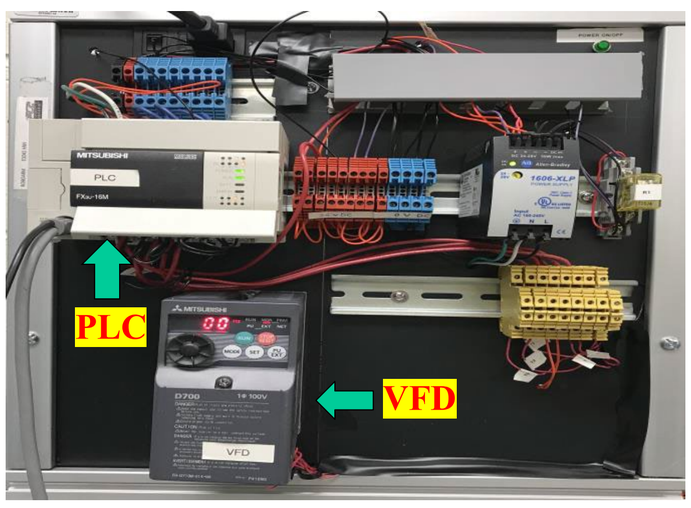

Fig 1: Front view of the panel

Main Components:

PLC: PLC (Programmable Logic Control) uses a programmable memory to store instructions and specific functions that include On/Off control, timing, counting, sequencing, arithmetic and data handling.
Specifications: Manufacturer: Mitsubishi
Model: FX3U-16MR/ES
Inputs type: 100-240 VAC 50 /60Hz 30 W
Output:24VDC 2A
Outputs type: Relay

VFD: A Variable-frequency drive (VFD) is a system used to control the rotational speed of an alternating current (AC) electric motor by controlling the frequency of the electrical power supplied to the motor.
Specifications:
Manufacturer: Mitsubishi
Input: 6.2a 1ph AC100-115V 50/60HZ
Output: 1.4A 3ph AC200-230Vmax/ 0.2-400HZ

HMI Screen: Human Machine Interface is a medium for information exchange and mutual communication between electromechanical system's and the user. It allows the user to complete settings through touchable images or keys on the user-friendly window.
Specification:
Manufacturer: Mitsubishi Type: 06705A
Power: 24VDC 7

Belt Conveyor 4N
Motor
Gearbox
Eye sensor
Proximity Sensor
Air cylinders
Festo Proximity Sensor Sunx Digital Fiber Sensor
Omron Inductive Proximity Sensor

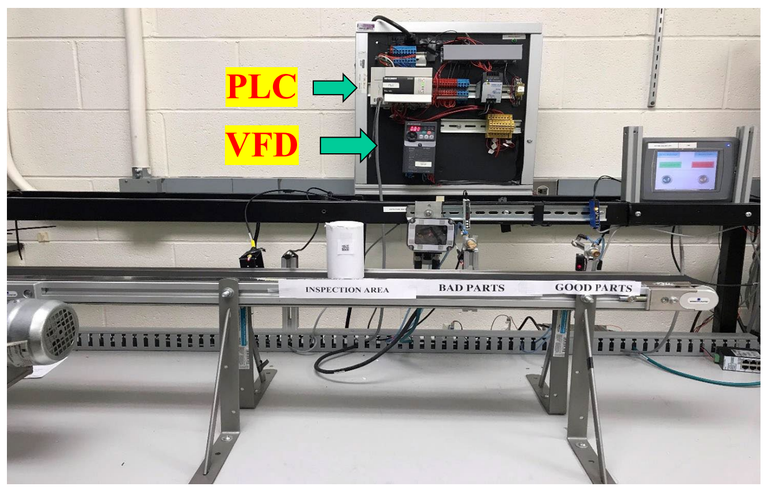

Fig 2: Front view of the Conveyor system.

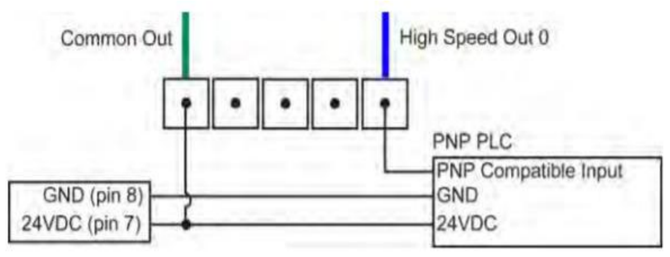

Fig 3: Wiring diagram between PLC and Cognex camera

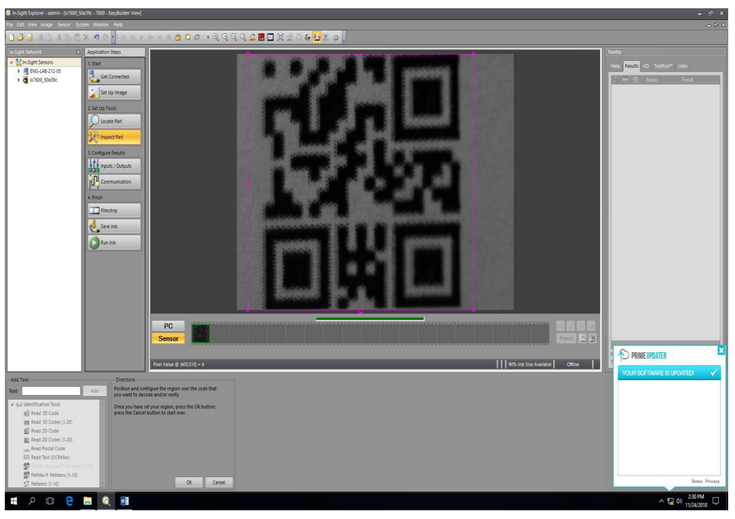

Fig 4: Teaching Barcode to Cognex camera

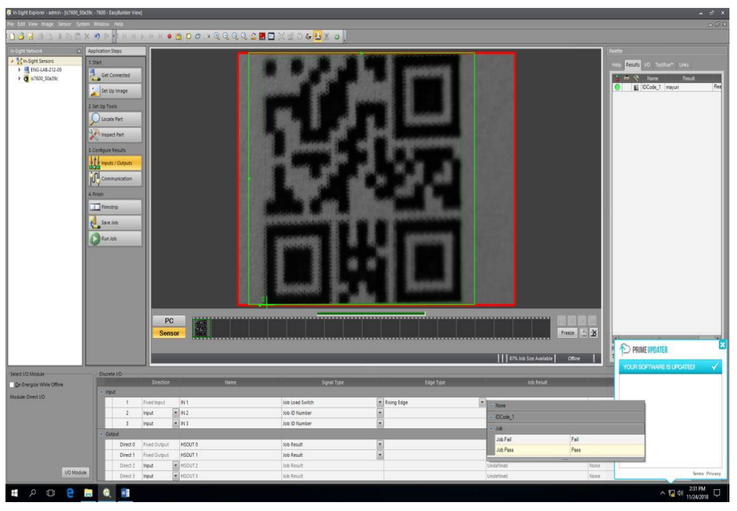

Fig 5: Good Barcode Detected by Cognex camera

Fig 6: HMI screen

Inputs and Outputs:

Inputs: X0- Bad part Proximity Sensor
X1- Good part Proximity Sensor
X2- Start Proximity Sensor
X4- Inductive Proximity Sensor
X6- HSC1 from Camera
X7- HSC2 from Camera
Outputs:
Y0- Speed forward (STF)
Y1-Air cylinder 1 (Good Part)
Y2- High Speed (90 Hz)
Y3-Air cylinder 2 (Bad part)
Y4- Medium Speed (20 Hz)
Timers:
T1- Time delay between bad part proximity sensor and Air cylinder 1
T2- Time delay for the Air cylinder 1 to keep actuated
T3- Resets Internal Bit
T4- Time delay between bad part proximity sensor and Air cylinder 2
T5- Time delay for the Air cylinder 2 to keep actuated
Counters:
C1- It is used to count the non-metallic cans with bad barcode
C2- It is used to count the metallic cans with good barcode.
Internal Bits:
M0- Start button
M1- Stop button
Other Internal Bits are used for Internal operations.
Data registers:
D1- Total parts counted
D2- Total good parts
D3- Total bad parts

Ladder Diagram

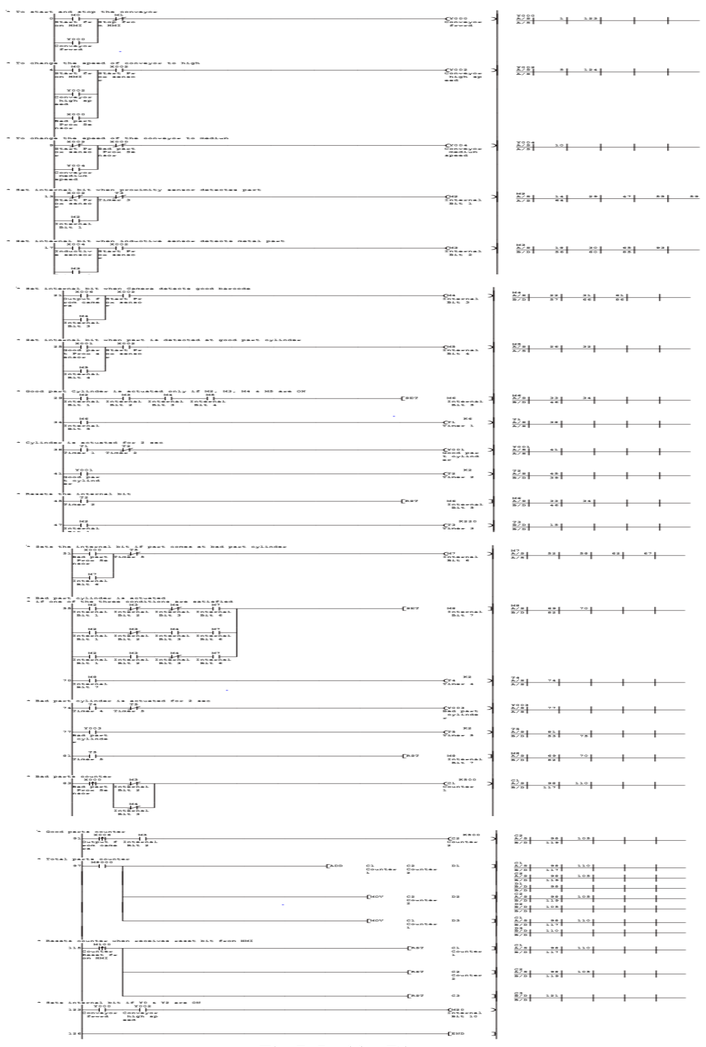

Fig 7: Ladder Diagram

Conclusions and Future Work:

Material Inspection and Sorting System prototype was developed and executed in Mitsubishi. Future aspects of the project is to change the Mounting and Lens of the camera so that the entire can details will be detected with reference so that we can include more parameters for inspection. Material Inspection and Sorting System is the movement, protection, storage and control of materials and products throughout manufacturing, warehousing, distribution, consumption and disposal. As a process, material handling incorporates a wide range of manual, semi-automated and automated equipment and systems that support logistics and make the supply chain work.